Diversity:
A Weapon of Mass Construction

"No Single Raindrop Believes It Is Responsible For The Flood"
despair.com

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I was asked to "Make it Personal"

- **Why am I here today?**
- **What made me become an advocate for Diversity? Especially since I'm:**

White - Northern European
Male
High level security clearance
Ph.D.
US born
Exit-seating capable

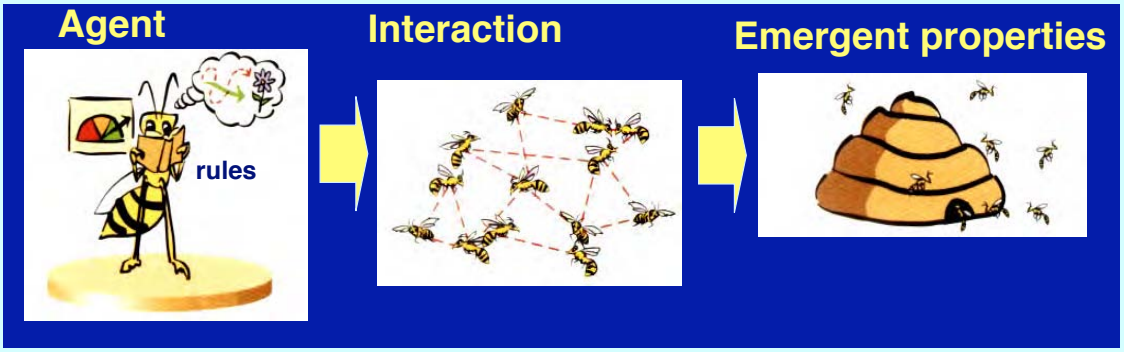
Roadmap to a Comprehensive View

- Self-organizing collective systems — Conflicting views of diversity
- Diversity and development — Unified in a model
- Effect of change — Dynamics look like “behavior”
- Effect of behavior — Lock-in of behavioral changes

Roadmap

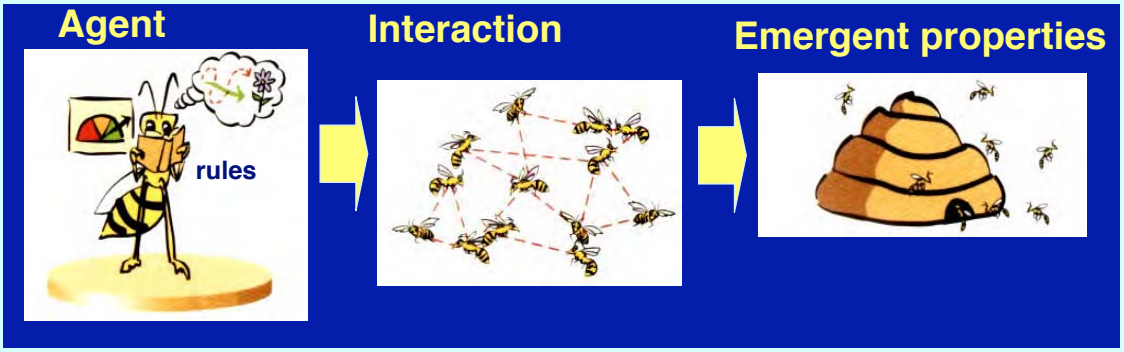
- Self-organizing collective systems — Properties
- Diversity and development — Diversity and synergy
- Effect of change — Conditions for synergy
- Effect of behavior
- More applications

Self-Organizing Collective Systems



A subset of complex adaptive systems

Self-Organizing Collective Systems



"Solutions" arise from the dynamics from a diversity of potential solutions.
Decentralized, robust, adaptable, fault-tolerant, scalable, ...

Fundamental concepts

Emergent properties

Chaotic behavior *or* non-linear response

Structure in chaos

Examples of Emergent Properties

Physical systems: viscosity is a property of a collection of atoms

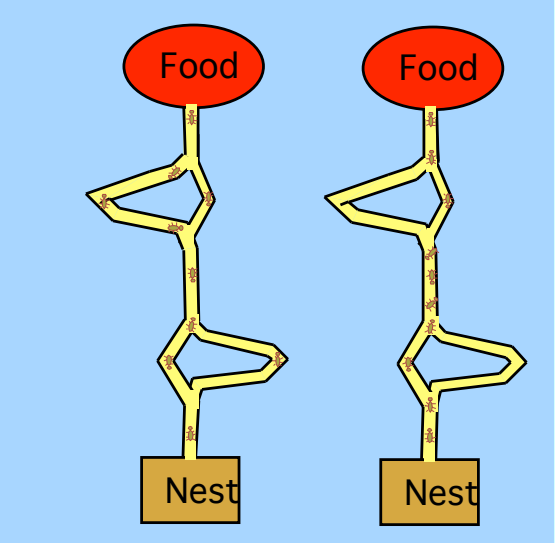
The Stock Market: no expert consistently beats the market as a whole (even including the "bad" investors)

Social insects

All of these present significant challenges to an "Expert" trying to describe how these work and to predict their future.

Ants Solving "HARD" problems

Most ants foraging for food find the shortest path.

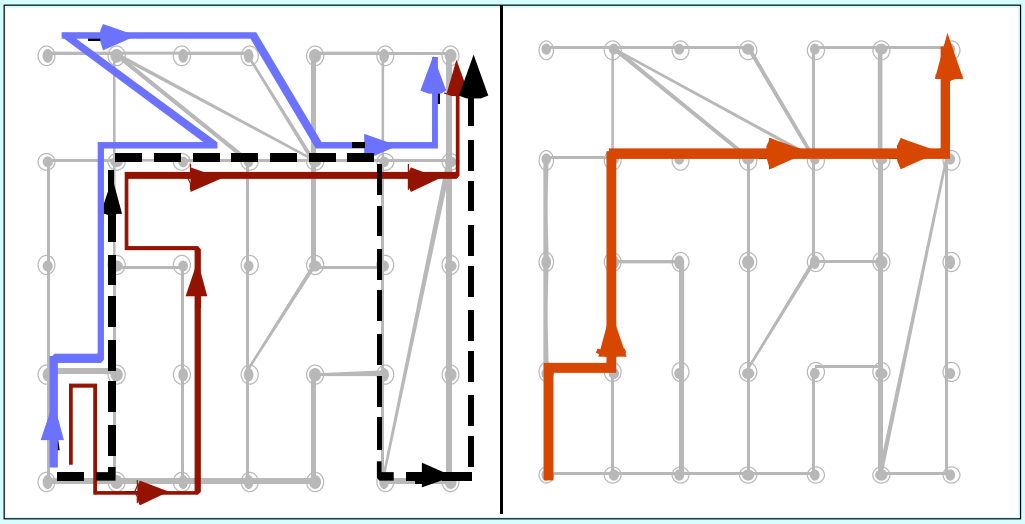


How is this possible?

- **No global perspective**
- **Individual behavior is "dumb" & chaotic.**
- **No leaders or central coordination**

How does it work?

How ants find the Shortest path



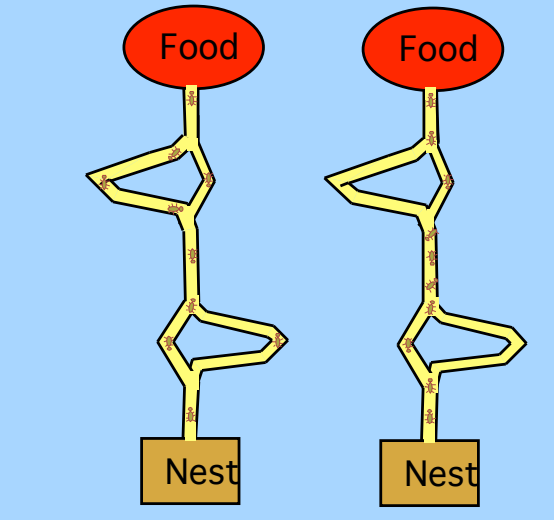
Paths of three ants

Collective path

Diverse pheromone trails (with or without evaporation)

Ants Solving “HARD” problems

Most ants foraging for food find the shortest path.



How does it work?

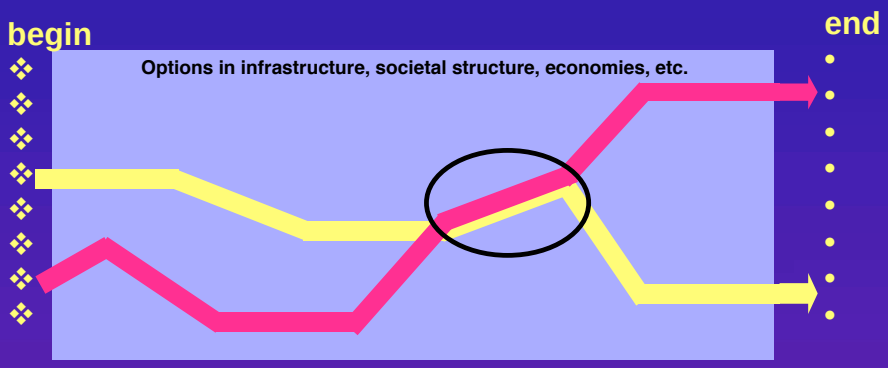
Only works for groups of diverse ants

Easy to show: suppose all the ants take the identical path. Then the collective cannot find the shortest path!

Collectives in complex environments

In complex domains:

- People's beginning points differ
- Their end points differ
- But local paths can overlay and find synergy



Diversity - source of conflict or synergy?

Diversity leads to synergy when collectives have:

- **Common goals**
- **Common identity**
- **Common worldview (agreement on options), but with different preferences or goals**

Otherwise, diversity can lead to competition and conflict

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One Business Argument

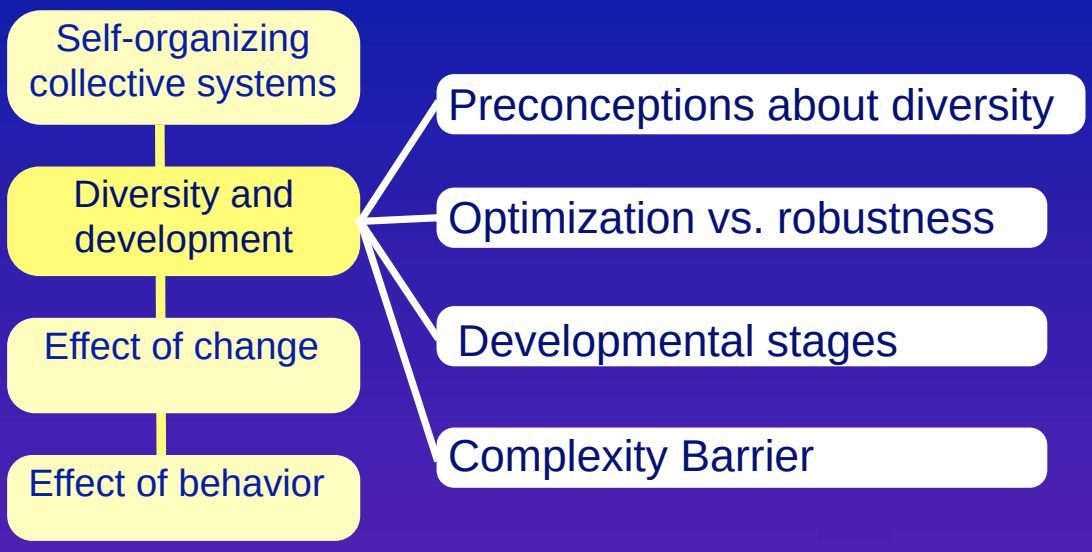
70% of our work knowledge is from informal sources
Two year, $1.6 million DOL study of Motorola, Boeing, Ford, etc.

$100-120 billion a year is spent on formal training programs,
Yet in complex situations, how is the "best training" determined?

Why are these informal sources helpful?
Individual problem solving in a common environment.
Diversity gives unique perspectives.
Individuals contribute to something much greater than they perceive.

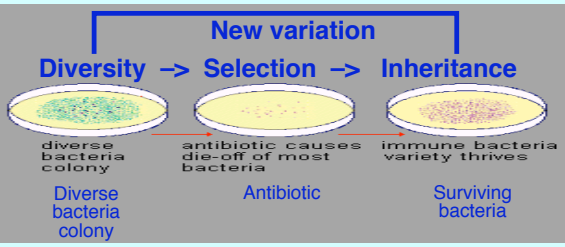
How do we tap the huge collective resources?
Investment in enabling Diversity activates informal learning.
Individuals expression, Listen to others, Mixing communities.

Roadmap



Diversity and Natural Selection

Engine of Natural Selection



Higher performance results as a consequence of selection from a diverse population.

Diversity lowers the global performance:

Lower performance of "unfit" individuals leads to lower "average" population performance

What does the research say?

Analytical

- Genetic algorithms ("natural selection")
- Iterated Games (Game Theory)
- Ant models

Emperical

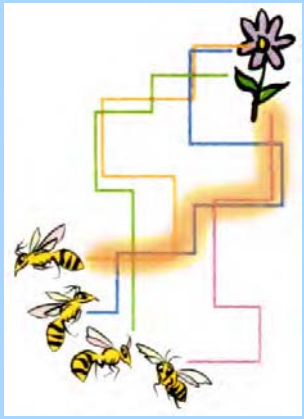
Harrington at Brown: small investment groups

Two Processes Using Diversity

Selection

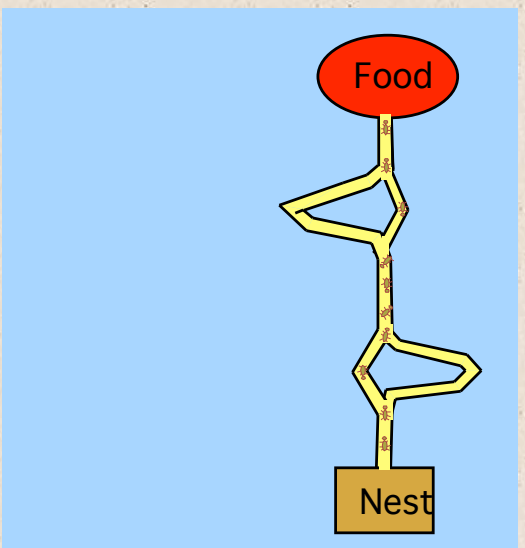
Selection **from** diversity improves the collective

Synergy



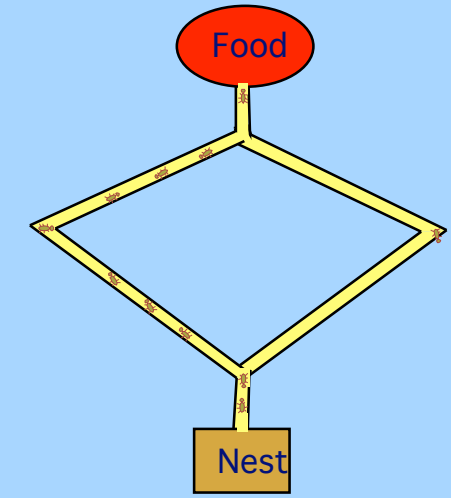
Synergy **of** diverse individual contributions without selection

An "Optimized" collective solution shows high performance , but diversity is restricted



The Problem with a Condensed Collective

- Ants foraging for food chose one path out of two equidistant paths.



(Deneubourg et al. 1990)

Cooperation leads to restricted diversity in stable environments

Non-linear or Chaotic behavior: Positive reinforcement can amplify random weak signals >> global chaos

Social insects planned for this…

Three Mechanisms for Collective Performance

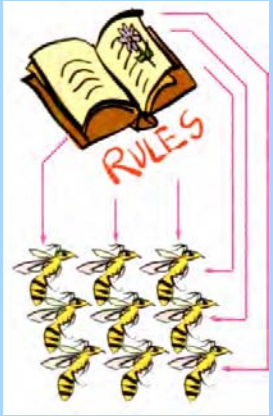
Selection

Selection **from** diversity improves the collective

Synergy

Synergy **of** diverse individual contributions without selection

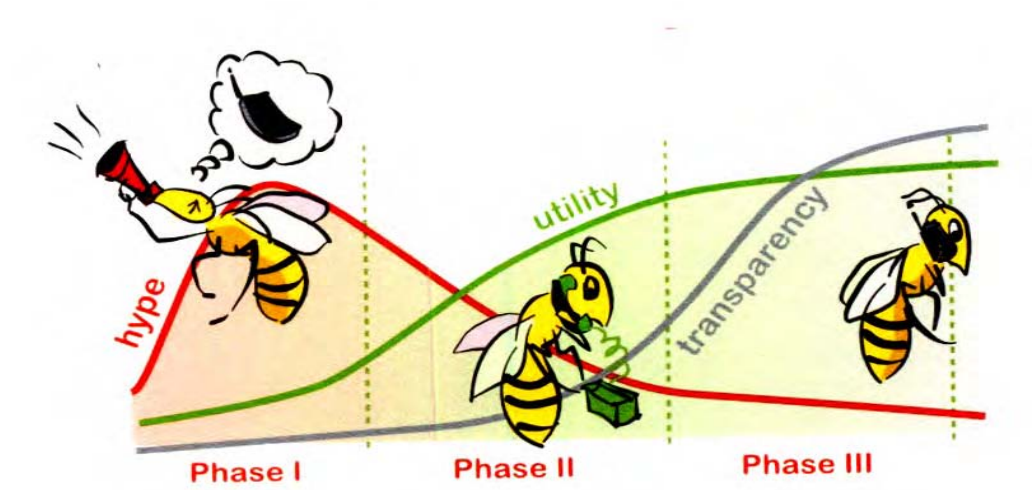
Optimization



Efficient, but little flexibility

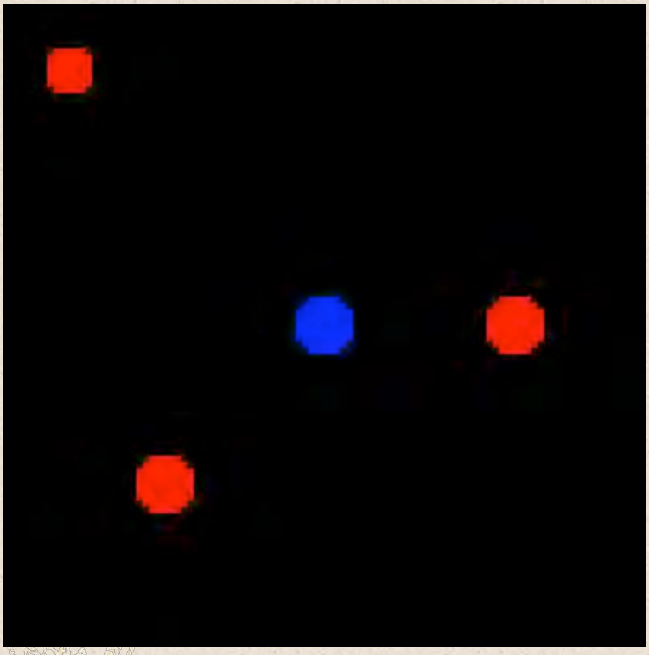
Almost everything has cycles or stages of development

Developmental Stages of Consumer Technology



And you act differently & system has different dynamics at different stages

Simple Ant Consumer Model



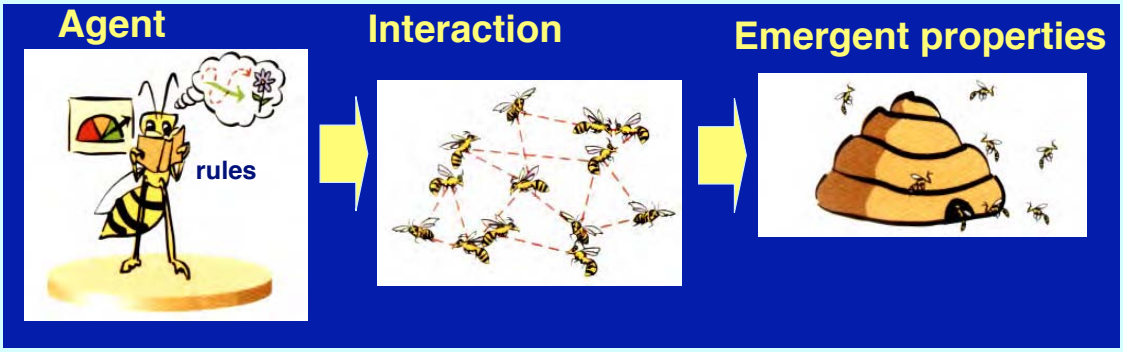
Collective information
- Evaporation
- Diffusion

Agent internal state:
- Current direction
- Have food?

Three rules of action:
- Carry food
- Drop food
- Search

Productive collective
"Salaried men"
Individual/Innovator
Collective structure

Self-Organizing Collective Systems



Fundamental concepts

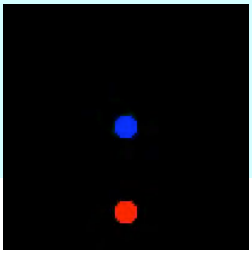
Emergent properties - Closest food, Shortest path

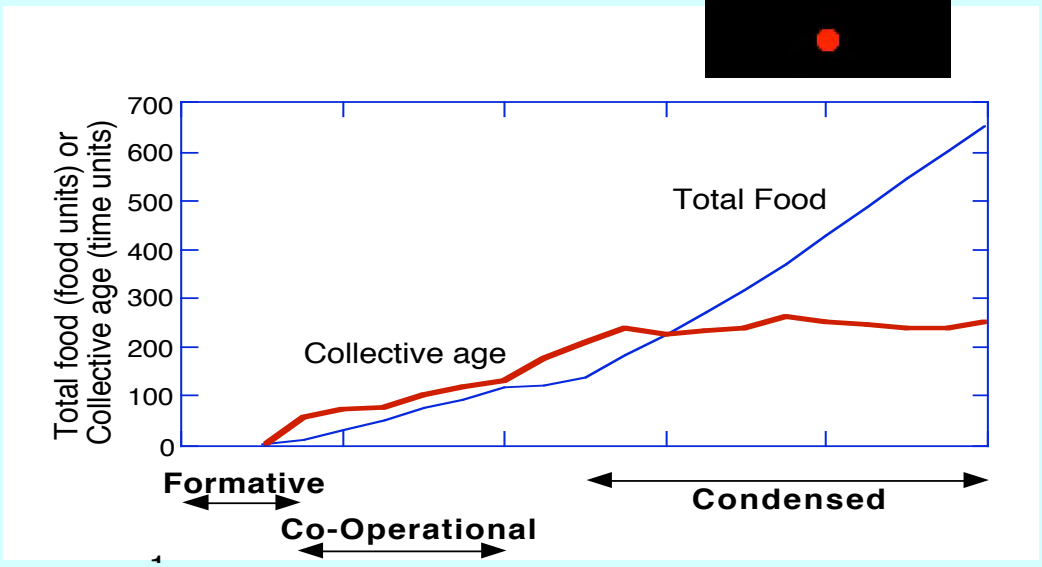
Chaotic behavior *or* non-linear response

Structure in chaos

Three stages for a stable environment

Total Production versus time



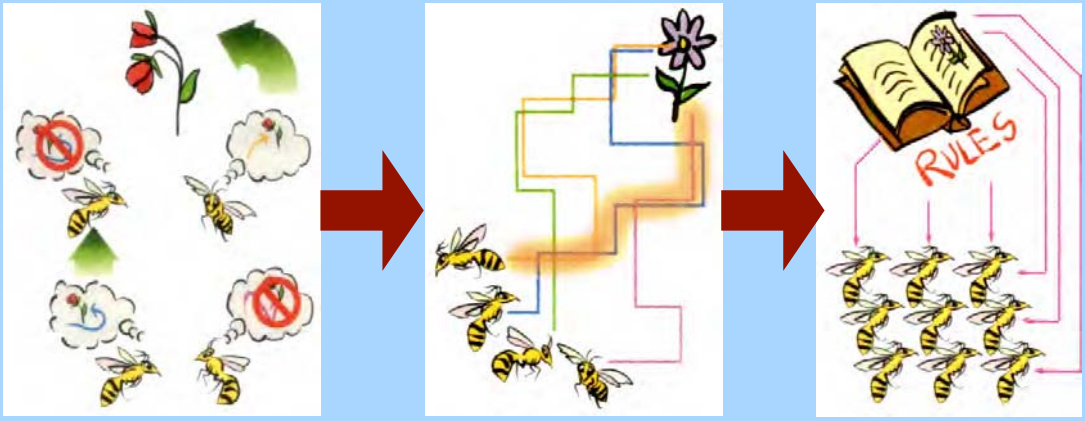


Stages of Collective Development

Formative
Form individual definition

Co-Operational
Improvement by collective

Condensed
System optimization



Now we can connect the three observations as three stages in one system

Stages of Development

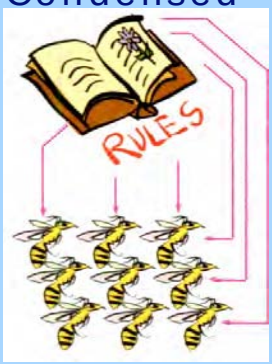
Formative

- Locally chaotic (agent's path)
- Globally chaotic (productivity)
- Robust global performance
- Production by "innovative" agents
- **High diversity**

Co-Operational

- Locally chaotic
- Globally predictable
- Robust global performance
- Production by both classes
- **High diversity**

Condensed



- Locally predictable
- Globally predictable
- Fragile
- Production by collective
- **Low diversity**

What is an Expert in your Area?

- *1. Someone that tells you the rules to make good decisions.*
- *2. Someone that gives you good decisions, but the rules claimed for his decisions aren't useful*
- *3. There are no experts.*

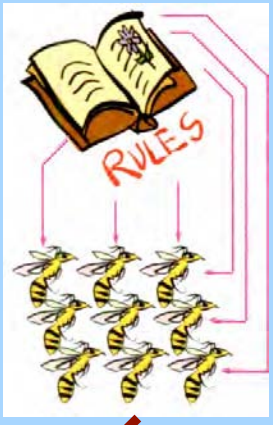
What is an Expert?

Someone that tells you rules or decisions?

- *"Expert" systems only work if the expert cognitively understands the system.*
- *In complex systems, expert are intuitive and can give good decisions without knowing why*
- *In highly complex situations, there are no experts and "Co-Operational" approaches are the best way to predict the future.*

Why not optimize directly?

Formative	Co-Operational	Condensed
Forming definition	Improvement by collective	System optimization



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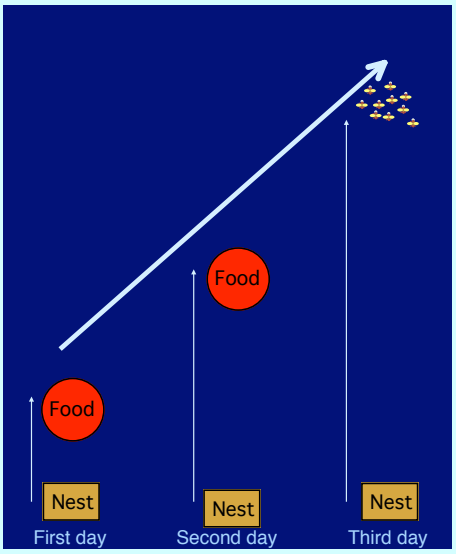
Complexity Barrier

Roadmap

- Self-organizing collective systems
- Diversity and development
  - Preconceptions about diversity
  - Optimization vs. robustness
  - Developmental stages
  - The complexity barrier
  - Why bees may inherit the ….
- Effect of change
- Effect of behavior

Researching Bee Talk



Where is the prediction taking place?

Where is memory located?

Bee memory - 1 week
Bee life - 6 week.
Hive memory - 12 weeks.

Why are social insects so disturbing?

All hive functions are emergent properties

Why aren't we as impressed with human collectives?

Roadmap

- Self-organizing collective systems
- Diversity and development
- Effect of change
- Effect of behavior

The Impact of Change on Ourselves

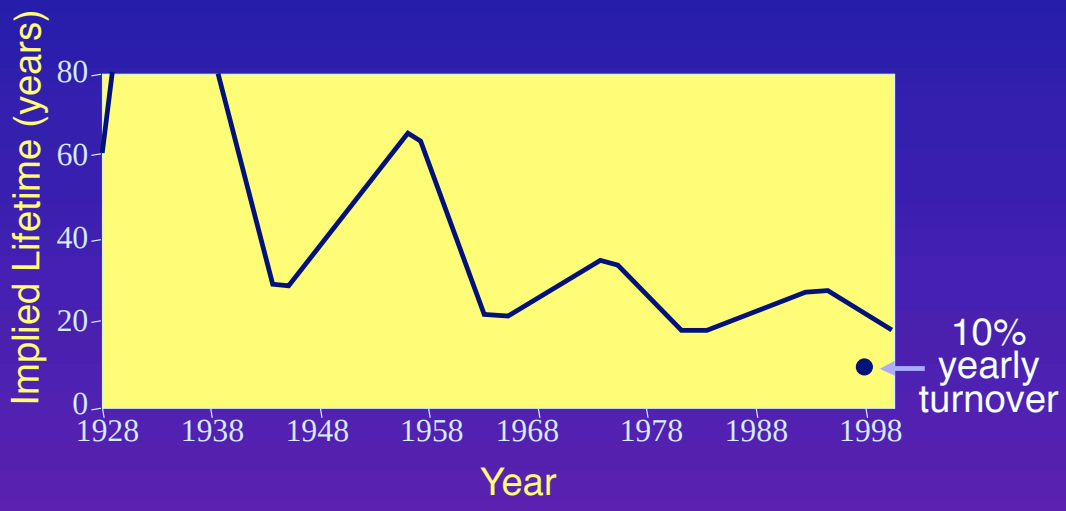
- Are you busier this year than last?
- Are you using more information sources than you did last year?
- Do you know more people than ever before? (but less quality ones?)
- Are you more uncertain about the future?
- Things that you thought would never change - are changing?

Why worry about change?

- Average Lifetime of S&P 500 Companies

From ***Creative Destruction***

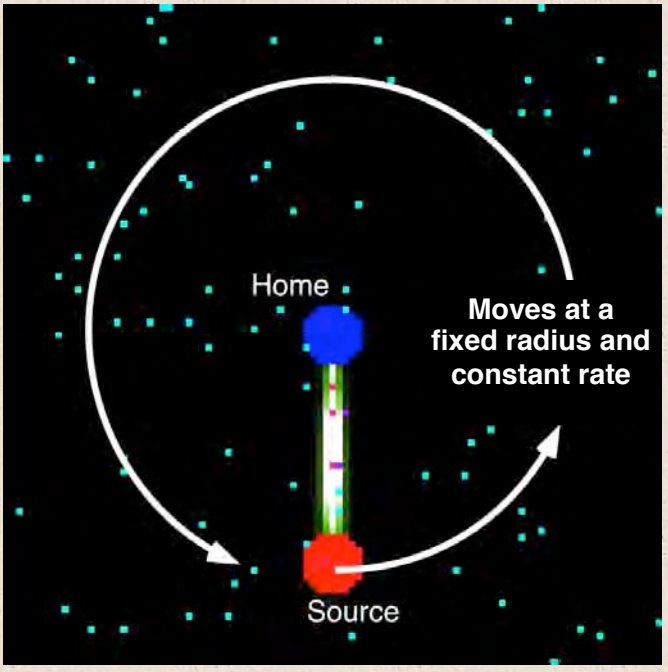
by R. Foster and S. Kaplan



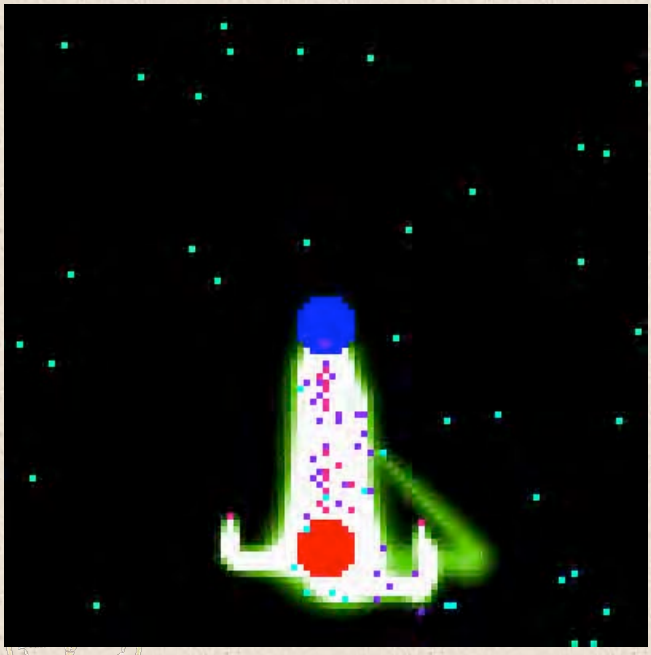
Roadmap

- Self-organizing collective systems
- Diversity and development
- Effect of change
  - Innovation by diversity
  - Boom and bust cycles
  - Collective inefficiency
- Effect of behavior

Collectives in a dynamics environment



Slowly changing environment

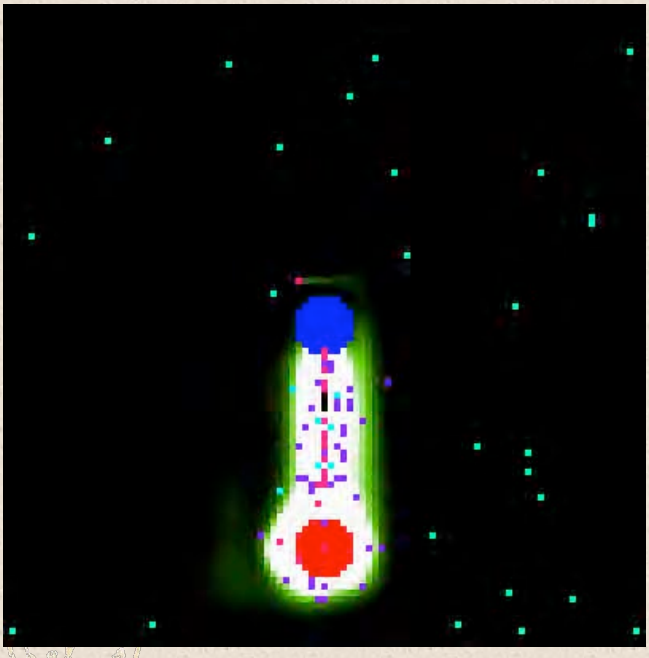


Productivity is only slightly less than an unchanging source

Herd effect allows for quick utilization of new resource location

Innovators become important (again) by sustaining optimal performance of the collective

Faster by 1/3

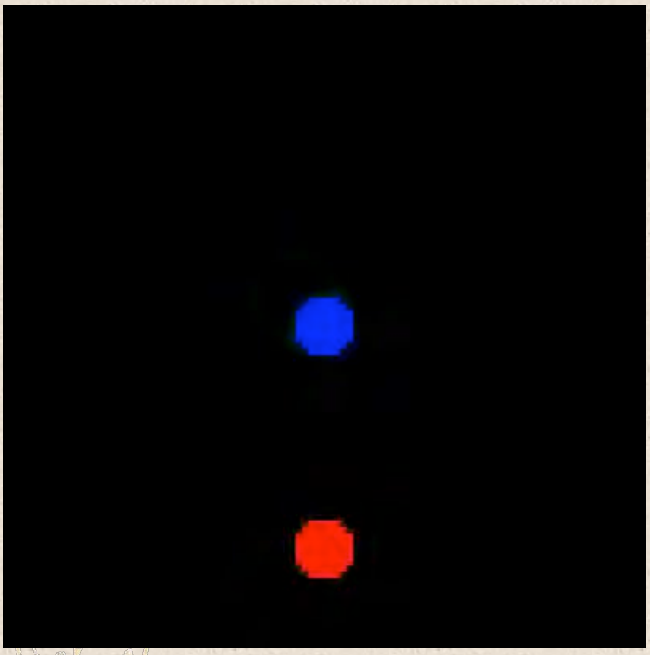


Boom and bust cycle

Instabilities lead to reversion to prior developmental stages

Equal importance of herd effect and innovators

Rapidly changing in environment

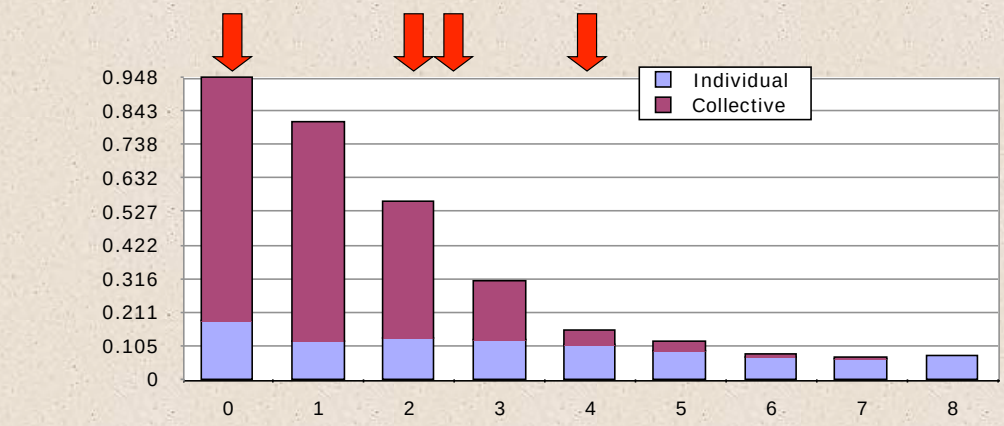


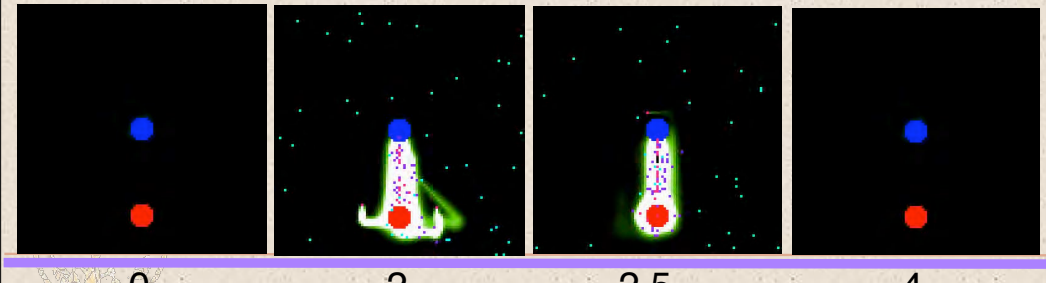
Almost all productivity is from innovators

The highly productive Optimized stage is never realized

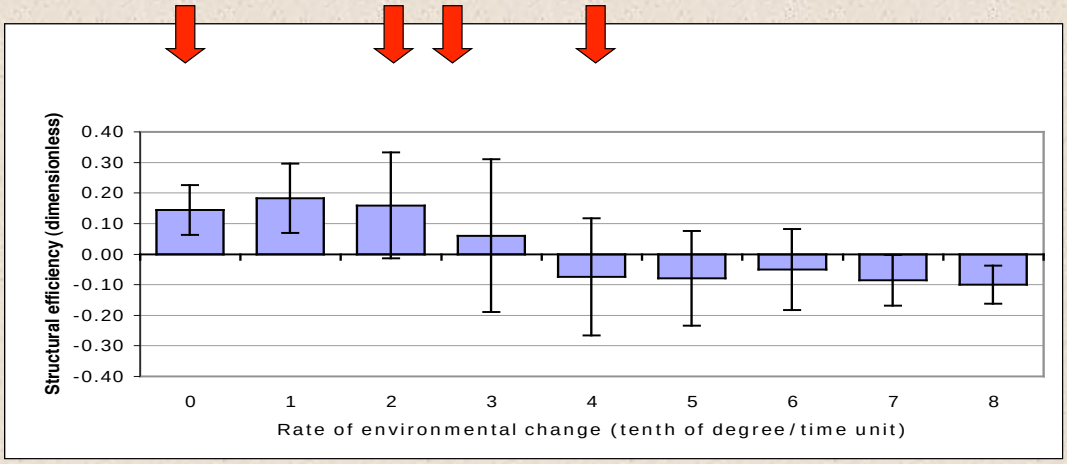
The herd effect actually degrades the performance by tying up resources

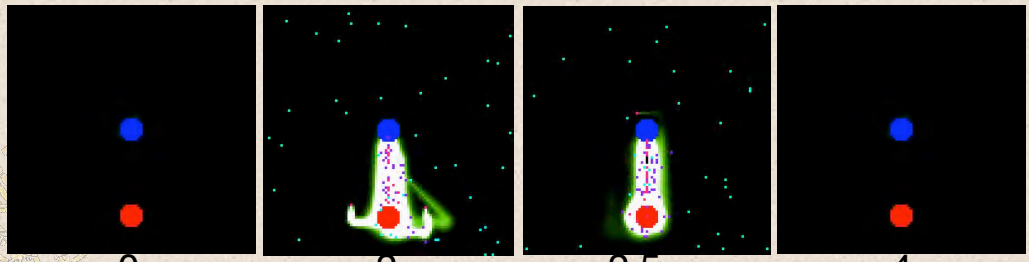
Food Production Rate





Collective efficacy (structural efficiency)





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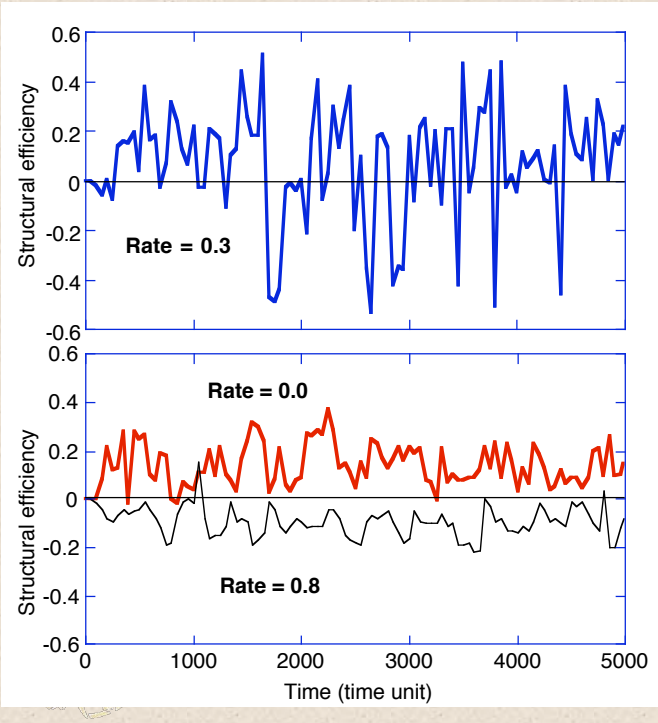
Structural Efficiency - Boom and Bust



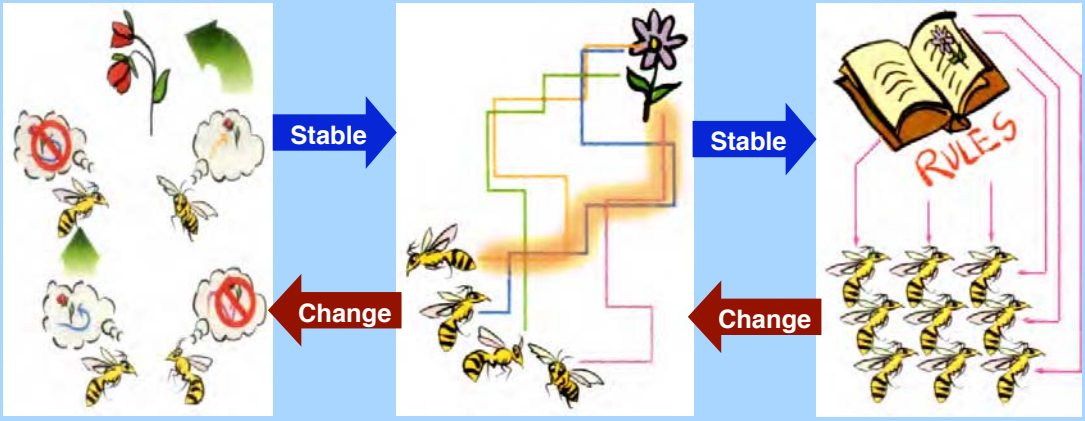
Lower average production --> need crash avoidance

Manic: Greater minimums and maximum when compared to extreme rates!

Bust is proceeded by increased production

Collective Response to Rates of Change

Formative Co-Operational Condensed



Rate of Change determines the final state

Sustainable strategies in fast changing times

Enable, manage and sustain diversity

Diverse groups = diverse information
Diverse groups best at recognizing the herd in action

Diverse groups optimal for vetting and amplifying innovation
Socialize "world views" and common understanding

Activate self-organizing processes

Keep strategic plans simple (Eisenhardt)
Focus on process, not products (process continually reinvents)

Improve your response to heard (herd) behavior

Recognize herding by loss of diversity and reduced social network
The herd solution will not be robust or optimal

Consider universal ethics vs. local community ethics

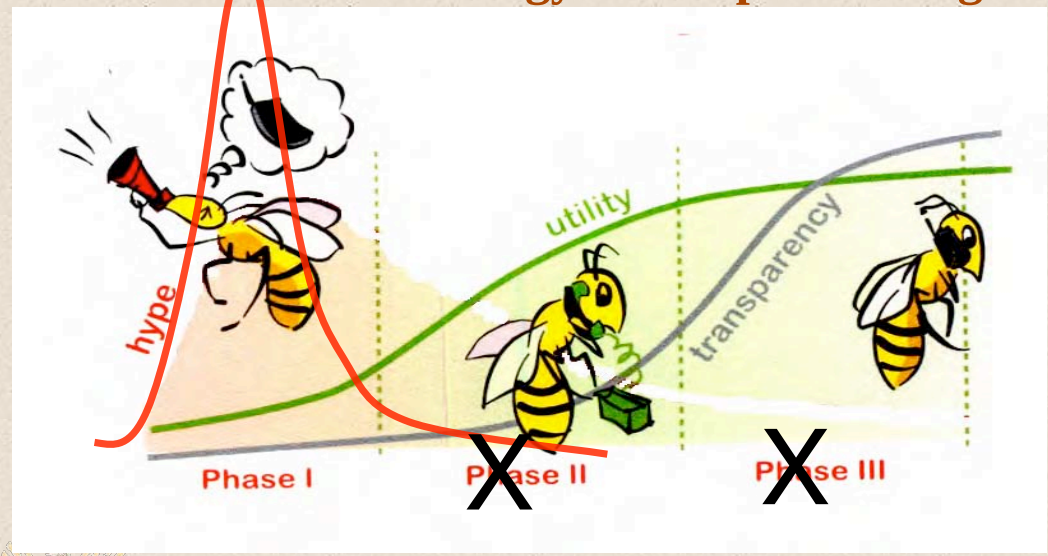
"Typical scientist … he never talked about emotions"

Roadmap

- Self-organizing collective systems
- Diversity and development
- Effect of change
- Effect of behavior
  - "Individual behavior complicates everything"
  - Individual behavior simplifies dynamics
  - Individual behavior can "lock-in" excursions in collective dynamics

What about individual & collective behavior?

Technology Development Stages



- Collective reinforcement of unsatisfied expectations can lead to an interruption of the developmental cycle

What does it mean to be "social"?

slime molds	"low" social insects	"high" social insects	social mammals	"low" apes	"high" apes	humans

Social: diverse, decentralized collectives solving problems - Collectively adaptable

Language, Collective memory

Individual reasoning and adaptation, emotions

Self-awareness
Consciousness

Sustainable strategies in fast changing times

Recognize stages
Enable, manage and sustain diversity
Activate self-organizing processes
Improve your response to herd behavior
Consider universal ethics

Recognize behavioral lock-in in clients and partners

Increased individual "rationality" may lead to destabilization and chaotic performance

Resist social copying under stress
Instead, increase your sources of diverse information

Test Questions

- Do you have a bumper sticker: "I brake for synchronicity"?
- Diversity on an assembly line?
- Have a drink, kill the weak brain cells and get smarter?
- What is your identity? Where do you store the catsup?
- The Complexity Barrier also applies to discrimination
- How to build a Democracy?

Are **WMC** like **WMD**? Which are not?

- Their use has significant consequences
- They are coveted by all
- They only can be created in mature societies
- Are reusable
- Those that have them, don't want others to have them
- Once they are out of the box, you can't put them back in
- They are selectively used by the powerful to justify their actions
- They require continual attention to keep them working

Diversity and Fast Changing times

"Problems cannot be solved at the same level of awareness that created them." *Albert Einstein*

Self-organizing collective systems	More widespread and important than commonly appreciated
Diversity and development	Diversity can lead to instability or better solutions, depending on complexity & identity
Effect of change	Innovation (diversity) is essential in coping with change
Effect of behavior	Our adaptations may not be optimal in dealing with change